The validity of Helianthus illinoensis Gleason as a species

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The plants to which the name *Helianthus illinoensis* Gleason was assigned were collected by Dr. H. A. Gleason on sand dunes along the Illinois River near Havana, Illinois, during 1903 and 1904, where they occur in the *Quercus velutina* association. The original description was published in the Ohio Naturalist (5: 214. 1904) and reprinted in "On the biology of the sand areas of Illinois" by C. A. Hart and H. A. Gleason (Bulletin Illinois State Laboratory of Natural History 7: 188. Ja 1907). The salient points in the description are as follows:

"Erect, six to ten dm. high, from a long running rootstock. Stem simple, slightly angled, densely villous below, pubescent above. Leaves six to eight pairs, strictly opposite, slightly scabrous above, softly pubescent beneath and villous on the veins, obtuse; the lowest four or five pairs oblong-lanceolate to ovate-lanceolate, three-nerved, entire, ten to fifteen cm. long, tapering at the base into a winged petiole equaling or but little shorter than the leaves; the upper two or three pairs much smaller or bract-like, petiole short or none. Lower internodes five to eight cm. in length, or the two lowest pairs of leaves approximate, upper internodes much longer. . . . Flowers in August. . . . *Helianthus illinoensis* is evidently closely related to *Helianthus occidentalis* Riddell, which it resembles in the reduction in size of the upper leaves. It is at once distinguished from the latter species by the villous pubescence and the greater length of the lower internodes. The two are sometimes associated in the field, but in general appearance they are entirely distinct. *Helianthus occidentalis* has broad, scabrous, light green, short-petioled leaves which are nearly erect in a basal cluster, while in *Helianthus illinoensis* they are darker green, more or less spreading and scattered on the stem."

The corresponding features of *Helianthus occidentalis* Riddell are thus characterized in Britton's Manual:

"Stems appressed-pubescent or sometimes nearly glabrous, slender, mostly simple, 6–9 dm. high. Leaves mainly basal, firm, ovate or oblong-lanceolate, obtuse or obtusish at the apex, narrowed at the base, 3–5-nerved, serrulate or entire, mostly scabrous above, pubescent beneath, with slender petioles."

In the American Naturalist (**42**: 73–80. F 1908), David Starr Jordan formulates what he terms the "Law of Geminate Species" in these words: "Given any species, in any region, the nearest related species is not to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort or at least by a belt of country, the breadth of which gives the effect of a barrier." This statement is given in slightly different words and amplified to make its application to plants more obvious by A. E. Ortmann (Science II. **27**: 427. 1908) as follows. "Closely allied species occupy neighboring areas; more or less closely allied species, occupying the same or nearly the same territory, generally possess different habits." This makes it clear that ecological as well as geographic segregation enters into the composition of species. Stated upon an ecological basis, this principle is that closely allied species ought not to occur within the same association in a given geographic area. Variations in any given species are always more or less marked according to local or edaphic factors. This variation, occasioned by environment, leads to extreme types between which there may be every gradation. In some cases only the extremes are noticeable but wider observation will reveal the intermediate steps. Ecological consideration of the factors involved clearly shows that these types are variations of one species. When variation in ecological factors has led to the production of two or more apparently well-characterized types, it is frequently necessary, for the sake of definiteness and conciseness in referring to them, to give them recognized names. These names, however, are not of really specific rank. In general, the normal type or the one from which the variations occur ought to bear the specific name and the well-characterized variations, especially those which are connected with the normal form by comparatively few gradations, ought to bear subspecific names, reserving the term "variety" to horticulture where it more properly belongs. Ortmann (Science II. **27**: 429. 1908) sums up the idea in the form of a rule. "If further studies should show that there is segregation, geographical or ecological, between these forms, then they are *species;* if not, they are *varieties* (= subspecies), which fact then also will be expressed in their morphological condition, one form running into the other at least in certain parts of their ranges."

As the plants under consideration were both found in the *Quercus velutina* association where it occurs on sand dunes, it seemed well to look into their status during 1908, when the sand areas of Illinois were studied by Dr. Gleason. During the early part of the summer, plants seemingly belonging to the new species were found associated with the *Quercus velutina* wherever that association occurred. The following are a number of localities in which this association was studied and from which plants in question were collected :

St. Anne, Kankakee Co., Ill. (*Gates 2437, 2439.*)
Hanover Station, Jo Daviess Co., Ill. (*2662, 2672.*)
Savanna, Carroll Co., Ill. (*2684.*)
Oregon, Ogle Co., Ill. (*2718, 2733.*)
Winthrop Harbor, Lake Co., Ill. (*2774.*)
Beach, Lake Co., Ill. (*2749, 2887, 2936, 2965.*)

In addition to these localities observations were made in Rock and Kenosha counties, Wisconsin, and McHenry Co., Illinois.

Nothing seemed to be amiss until near Winthrop Harbor, Illinois, it was discovered that plants which in the spring and early summer were *H. illinoensis*, were at the time of blooming and fruiting simply *H. occidentalis*. This observation led to careful study of these plants wherever they were found during the season of 1909. The conclusions that were inevitably drawn were that *H. illinoensis* was an ecological subspecies of *H. occidentalis*, provoked in response to severer xerophytic conditions or increased food supply. Accordingly I propose that these plants should bear the name :

Helianthus occidentalis illinoensis (Gleason) Gates, comb. nov.

Helianthus illinoensis Gleason, Ohio Nat. **5** : 214. 1904.

Helianthus occidentalis grows both in the black soil prairies of Illinois, etc., and in the sand areas which are distributed over the north and central parts of Illinois. In so far as could be observed those plants of this species growing in the black soil prairies showed no indications whatsoever towards modification in the direction of the subspecies. The latter is a plant of sand regions, but the mere growing of the type in sand does not necessarily mean that any characters of the subspecies will appear. In all

situations this species grows erect from a long running rootstock, by means of which propagation is usually effected from year to year. Reproduction by seeds does not seem to be customary in view of the scarcity of seedlings observed. Observations on the association of the individual seedlings, in the Beach region at least, seemed to point to the dissemination — not of the seeds separately — but by heads containing the full quota of seeds or nearly so. At all events vegetative propagation and reproduction soon lead to the formation of a patch of plants. The patch is usually a closed association and admits of but few interstitials (such as *Polygonum tenue* or *Arabis lyrata*), while on the other hand the patch may spread outwards for a meter or more. It was this assemblage in patches that furnished the key to the situation. It was very plainly evident that edaphic factors varied within the extent of the patches. Of these the most important were light and soil. Another factor, water supply, due to varying amounts of precipitation, varied from season to season and also within a given season. These three factors, acting either singly or conjointly with the compound factor, wind, may produce the subspecific type, *H. occidentalis illinoensis* on sandy soil. In so far as could be determined, the greater amount of pubescence which is characteristic of the subspecies, *H. occidentalis illinoensis*, was to afford the plant adequate protection from excessive transpiration brought about by varying edaphic conditions. Light, acting singly while the other factors mentioned were constant, could produce the subspecific type, provided the physiological water-content of the soil was such as to make the transpiration ratio (*i. e.*, the amount of water transpired divided by the amount of water taken up by the plant) at or below the critical point for the particular plants. Some patches were found which extended from the full sunlight up into the fairly dense shade of oak trees and in every observed case those plants which received full sunlight were more pubescent than those in the shade.

It is, however, only in case the water supply is deficient that the difference in pubescence is so marked as to constitute the subspecific type. Long lower internodes are characteristic of the subspecies but several examples of plants growing in full sunlight with a dense villous pubescence had internodes but very little longer

than the normal type. It seems quite likely that this is due to the inhibiting action of excessive light upon plant growth. Typical plants of this species when growing on sandy soils normally occur in the shade. When growing in the sun on the black soil prairies of Illinois no deviation from the specific type was observed. In the case of the sand prairies of the Beach region the few cases that were found showed otherwise. In a few places where patches of this sunflower extended from the sandy soil into the edge of the prairie, whose soil, though essentially sandy, was gray on account of admixture with humus, the plants growing in the latter situation had the appearance of the subspecies while those that were in the purer sand remained characteristic of the species. It was very evident that both extremes had arisen from the same parent stock. This shows the tendency of an increased food supply to produce larger plants of the long internode type. The increased pubescence seems always to accompany the long internodes, while the latter may be virtually absent in cases where the former is present. Plants growing in sand mixed with humus under the shade of the oaks (*Quercus velutina*) generally responded with longer internodes. This was, of course, accentuated in the diminished light. The presence of the villous pubescence, which usually is regarded as a protection against excessive transpiration, is not so easy to understand, for the transpiration under the shade of the oaks is obviously not so great as in the open sunlight. As the soil is richer and there is no appreciable difference in the water supply, it may be that the hairs are produced from an excess of materials taken up into the plants, as is suggested by Strasburger for other more or less similar cases and for the grit cells of the pear.

The remaining factor that has the power to influence in the production of the subspecific type is the available water-content of the soil. A physiological water supply which is too low decreases the amount of water available for transpiration, consequently induces pubescence. Obvious excess of water supply was not observed and very likely seldom occurs, as water in the form of rain sinks rapidly through the sandy soil of the *Quercus velutina* ridges upon which this *Helianthus* grows. Normally a sufficient supply of the water is left in the sand as films around the sand grains. As is very well known, rainfall varies widely both from

season to season and even within a given season. This has a decided effect in the production of the subspecific type, as is shown in the following examples. The spring and the first part of the summer of 1908 were characterized by extreme and protracted drought in Illinois. During that time, almost without exception, plants of this sunflower were densely pubescent and had long internodes, whether they occurred in sun or in shade, in poor soil or in a richer soil. This is characteristic of *H. occidentalis illinoensis*. The drought was broken in August in Lake County, Illinois, and the result was that virtually all the plants, some of which had been definitely marked, lost their pubescence and to all intents and purposes were normal *H. occidentalis*. The season of 1909 had abundant precipitation throughout and during that entire year but very few plants were found that could be referred to *H. occidentalis illinoensis*, even in patches which the spring before had been dominated by that type.

Helianthus occidentalis easily maintains itself on the sand but it may also occur on black-soil prairies without apparent modification. In addition, it may occur on sand prairies where, near Winthrop Harbor at least, it is barely able to hold its own. In such situations, however, the plants are of the pubescent, long-internode type. The subspecific type, termed *H. occidentalis illinoensis*, always occurs in sandy soil, within or near the limits of the *Quercus velutina* association, where it is a response to edaphic conditions in the environment which increase the amount of food supply or which increase the transpiration on a soil more or less deficient with respect to either or both of the factors, physiological water supply and food materials.

The preceding conclusions have been based on field observation alone. Culture of the plants under control conditions will in the future give more conclusive results.

URBANA, ILLINOIS.